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PSYCHE

VOL. XXV JUNE, 1918 No. 3

ON THE EXISTENCE OF IMMUNITY PRINCIPLES IN INSECTS.[1]

By R. W. Glaser.

During the course of my work on various diseases of insects, I have often been confronted by results which seemed to point towards the existence of immunity principles. I failed to become convinced, however, till I instituted a series of experiments meant to prove or disprove my views. Other workers, also, on investigating caterpillar and grasshopper diseases, have been unable to explain some of their results without assuming the possibility of physiological immunity, but direct proof for their contentions has been lacking.

In physiological work of this sort it is very difficult to obtain quantitative data for the reason that the amount of blood obtainable from a particular insect amounts to only one-tenth to one-fifth of a cubic centimeter. In one series of experiments I managed to obtain quantitative results. The other data are qualitative but, I hope, no less important.

The Question of Phagocytosis.

Since all entomological text-books emphasize the importance of the blood cells in ridding the insect body from the invasion of foreign substances this question was first investigated. In practically all the literature on the subject, insect blood cells are compared with the mammalian white blood corpuscles. An exceedingly aggressive nature is attributed to them and their movements are described as actively amæboid, engulfing foreign substances with great avidity. I was greatly astonished to find that this view was incorrect and that the blood cells are visibly rather passive. Of course, we know that the so-called amæbocytes play an important rôle during metamorphosis, and I do not wish to create the

[1] Contribution from the U. S. Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution, No. 143.)

impression that I depreciate the importance of these cells. However, even during metamorphosis their action is not confined to an aggressiveness manifested by movement but rather, I think, to an increase in the secretion of proteolytic and perhaps other enzymes. These break down the larval tissues and prepare the various proteins and other substances for assimilation by the imaginal disks that form the adult tissues.

One gains the impression from text-books that the insect blood cells, called amæbocytes, during metamorphosis, bodily attack those larval tissues destined to destruction; that they swallow masses of such tissues, digest them and then wander over to the imaginal disks where they surrender the digested matter. I will attempt to show that insect blood cells are nor quite as aggressive, as we have been persuaded to suppose, and that one can stimulate the formation of certain substances acting extracellularly. It may be true that these substances are formed by the cells but, on the other hand, it is also possible that they are formed by the blood plasma or serum. After they are formed, however, they act independently of any cellular organization.

During 1916 and 1917 while studying certain bacteria pathogenic to caterpillars, and others pathogenic to grasshoppers, I had occasion to inoculate many insects with different cultures. In some of my experiments several of the insects lived in spite of the fact that enormous numbers of microörganisms, supposedly pathogenic, were introduced. For example: Ten mature female grasshoppers (*Melanoplus femur-rubrum*) were each injected with $^1/_{10}$ c.c. of a 24 hour bouillon culture of *Bacillus poncei* Glaser. *B. poncei* is a highly motile organism which I obtained from the Honduran government in 1915. The bacterium is ordinarily pathogenic to *M. femur-rubrum*. After intervals of $\frac{1}{2}$, 1, 2, and 24 hours the animals were killed and a large metathoracic leg removed from each by breaking the joint between the trochanter and femur. The blood that oozed from each animal was caught on a separate sterile cover-slip. Some of these preparations were fixed by passing through a Bunsen flame, others were immersed in 70 per cent. alcohol, while still others were fixed with Schaudin's corrosive sublimate solution. After fixation, the preparations were dried and stained with methylene blue. Excessive staining can be remedied, of course, by treatment with alcohol. After mounting

the preparations were studied and I was astonished to find that they were surprisingly free from *Bacillus poncei*. Six of the smears showed no microörganisms whatever, the remaining ones showed a few bacilli scattered about here and there outside of the blood cells. On examining each smear carefully by studying ten fields with the oil immersion lens, I found only one blood corpuscle with *B. poncei* embedded in its cytoplasm. If the grasshoppers had been permitted to live, I feel sure that only the four revealing any bacteria in the blood would have finally died of the disease. The remaining six would have lived till they succumbed to natural causes. Two animals were examined after ½ hour; two after 1 hour; two after 2 hours and four after 24 hours. The bacteria were found in one case examined after ½ hour, in two examined after 2 hours and in one examined after 24 hours. This experiment was repeated with similar results.

In many of the inoculation experiments with *B. poncei* from one-fourth to one-half of the animals did not die and I then assumed that the blood acted antagonistically towards the introduced bacteria. The blood tests cited above seemed to be evidence in favor of this view. The blood of a certain number of the inoculated animals managed to rid itself of *B. poncei* and, moreover, this riddance was not accomplished by hungry amæbocytes as the text-books would have us believe. If the grasshopper blood cells had phagocytised large numbers of the bacteria I surely would have noticed this in the stained smears. In some cases the blood, however, acted antagonistically towards the bacteria and I will later show more clearly that the antagonistic substances are extracellular and therefore in the blood plasma or serum.

I thought that the tissue culture method might offer some interesting possibilities in studying, *in vitro*, the behavior of insect blood cells towards bacteria. The method for preparing such cultures is very simple and does not differ materially from the well known methods used by Harrison, Carrel, etc. for the cultivation of embryonic mammalian tissue. I shall not describe a method familiar to all biologists.[1]

The results of the following four experiments may be considered characteristic for a large series performed with both grasshopper

[1] Those interested in the cultivation of insect blood cells may be referred to R. W. Glaser: "The Growth of Insect Blood Cells in Vitro." PSYCHE, Vol. XXIV, No. 1, 1917.

and army worm blood. The blood of *Melanoplus atlanis* was used for these four experiments and *Coccobacillus acridiorum* d'Herelle, pathogenic to grasshoppers, was the organism used for the artificial contamination of two of the four tissue culture slides. Two slides were considered as checks. They were prepared by mixing a drop ($^1/_{10}$ of a c.c.) of the grasshopper blood with a drop of sterile, neutral, nutrient bouillon. The first day all of the blood cells appeared perfectly normal. On the third day some showed signs of disintegration, whereas others remained normal. On the sixth day the cells destined to disintegrate were completely disorganized. The others remained normal and showed cell division with the formation of syncytial, tissue-like masses. After two weeks the cells still appeared normal and the syncytia had increased considerably in size. The observations were not continued after two weeks. Throughout the entire period the slides had remained perfectly sterile showing that all technical precautions, observed during their preparation, had been adequate. At no time, not even during the first day before the formation of fibrin, did I observe any independent movement on the part of the blood cells. They remained passive and the only visible independent activity observed consisted in cell division on and after the sixth day.

The two experimental slides were prepared by mixing a drop of the grasshopper blood with a platinum loop-full of a 24 hour culture of the *Coccobacillus acridiorum* d'Herelle, a highly motile organism. The slides were examined as soon as prepared. The blood cells appeared to be perfectly normal and remained entirely passive. The preparations were swarming with the motile bacteria and in ten to twenty minutes many of the bacteria made their way into the cytoplasm of the blood cells. The latter did not engulf the bacteria which seemed to bore their way into the cytoplasm.[1] On the third day the bacteria were no longer motile. They seemed to be multiplying, but appeared in bunches simulating agglutination masses. Some of the blood cells had disintegrated; others appeared perfectly normal and bacteria were no longer visible within the cytoplasm. On the sixth day the bacteria seemed to be in about the same condition; multiplying, bunched and

[1] This may have been due to surface tension. It may be called phagocytosis if the word is used in a broad sense.

motionless. The blood cells showed cell division and the formation of the tissue-like, syncytial masses. Bacteria were not found within the cytoplasm of any of the cells. In two weeks the two culture slides presented much the same condition with the exception of the blood cell syncytia which were much larger. The observations were discontinued after two weeks.

The foregoing experiments were repeated with army worm and gipsy moth caterpillar blood. The results were in perfect harmony with the grasshopper blood observations.

From the tissue culture work, we are forced to conclude that in a mixture of insect blood cells and bacteria, the blood cells are not the visible aggressors. However, the blood seems to be able to overcome bacterial invasion to a certain extent. Substances are elaborated which antagonize the bacteria. On the culture slides, the quantity of the blood is not sufficient, and metabolism is lowered, so that antagonistic substances are not formed so rapidly nor so abundantly as is the case within the body of the insect. For this reason, although the bacteria were rendered ineffective on the culture slides and permitted the blood cells to grow, they were not killed. All of these questions will be more clearly elaborated in the next section.

Extracellular Antagonistic Substances.

In a large series of experiments with grasshoppers (*Melanoplus femur-rubrum*) and *Bacillus poncei* four animals remained alive after two weeks. These animals, like the remainder, which died, had been injected with $^1/_{10}$ of a cubic centimeter of a 24 hour bouillon culture of *B. poncei*. I suspected that these four animals were immune and thought it might be possible to demonstrate the existence of some immunity principle, such as an agglutinin. Of course, on account of the small amount of blood obtainable from a grasshopper, it is extremely difficult to perform a Widal test with all the high dilutions, but I am confident that my experiments are significant in spite of this shortcoming.

Four depression slides were prepared from the four supposedly immune animals. A leg from each grasshopper was broken and a drop of blood from each was caught on a separate sterile cover-slip. To each cover-slip I added one platinum loop-full of a 24 hour bouillon culture of *B. poncei*. The culture was first examined

microscopically and the organisms were found to be highly motile. The cover-slips were kept under observation and at first the bacteria swarmed about everywhere at an exceedingly lively rate. The motility seemed to diminish in a few minutes and in 20 minutes to ½ hour the bacteria had agglutinated in large masses and seemed to be dead to all appearances. The four tests were identical and I never saw a better reaction with *Bacillus typhosus* and typhoid serum.

Four depression check slides accompanied the four used in the experiment. These were prepared by adding *B. poncei* to normal *Melanoplus femur-rubrum* blood. The bacteria remained motile till the next day.

The eight slides were prepared under sterile conditions and the edges of the coverslips sealed with sterile vasalene, so that I was able to keep them for six days. At the end of that time when I examined the preparations the agglutination masses presented the same appearance in all four experimental slides. The blood corpuscles, however, had divided and formed syncytia. I inoculated culture tubes from these four slides, but obtained no growth, proving that all the bacteria had been killed. The four check slides proved to be interesting in a different way. On them the bacteria were not motile, but long chains were visible showing life. In some places the bacteria were bunched, but no true agglutination masses were found. On check slide 4 the blood showed signs of growth through the formation of syncytia. The blood corpuscles seemed not to have grown on the other three preparations. Culture tubes were inoculated from these check slides and pure cultures of *B. poncei* were obtained from all.

I thought it would be interesting to obtain some quantitative data in regard to the bactericidal action of immune insect blood. Sixteen *M. femur-rubrum* grasshoppers were injected each with $^1/_{10}$ c.c. of a 24 hour bouillon culture of *B. poncei*. In ten days all but three had died, and since no deaths were recorded for four days I assumed that the three living animals had acquired immunity against the bacteria. Small samples of blood removed from each showed no bacteria microscopically. Under sterile conditions the following experiments were performed in small test tubes. Adequate checks accompanied the series.

Experiments.

(1) 2 drops[1] ♀ *femur-rubrum* immune blood + 1 c.c. bouillon + 1 loop of *B. poncei.*
(2) 2 drops ♀ *femur-rubrum* immune blood + 1 c.c. bouillon + 1 loop of *B. poncei.*
(3) 2 drops ♂ *femur-rubrum* immune blood + 1 c.c. bouillon + 1 loop of *B. poncei.*

Checks.

(1) 2 drops bouillon + 1 c.c. bouillon + 1 loop of *B. poncei.*
(2) 2 drops ♀ *femur-rubrum* normal blood + 1 c.c. bouillon + 1 loop of *B. poncei.*
(3) 2 drops ♂ *femur-rubrum* normal blood + 1 c.c. bouillon + 1 loop of *B. poncei.*

The six test tubes were incubated for 24 hours at 35° C. At the end of that period neutral potato agar plates were poured from the six cultures using the customary one, two, and three dilution method. Each experiment and each check was represented by three plates making eighteen plates altogether. They were incubated for three days at 35° C. after which a count was made of the developed colonies. The colonies on the six first dilution plates (experiments and checks) were too numerous and confluent for counting. Those on the six second dilution plates were also extremely numerous. At a glance one could tell that the colonies on the check plates were more numerous than on the experimental plates. By taking counts of sections of all the plates I arrived at the conclusion that the ratio of check to experimental colonies was about 10: 1.

With the six third dilution plates I was able to make actual colony counts for the three experiments and three checks.

Number of Colonies on Third Dilution Plates.

	Checks.	*Experiments.*
(1)	7	0
(2)	4	0
(3)	6	0

As can be seen from the foregoing table Checks 1, 2, and 3 gave 7, 4, and 6 colonies respectively, whereas nothing at all was obtained on the three third dilution experimental plates.

These experiments taken in conjunction with the other results I have presented show that it is possible to bring about the formation of bacteriacidal properties in some insects. From my tissue culture work discussed under phagocytosis, I have shown that normal insect blood is somewhat antagonistic towards bacteria,

[1] Two drops equals 1/6 of a cubic centimeter. This is the maximum amount of blood which one can obtain from one animal at a time.

but this antagonism is much more evident in animals that do not die after a bacterial infection, i.e., animals which are immune.

If it were only possible to inject an insect more than once without producing fatal results, I am sure one could obtain still more interesting results. I have often made two trials but grasshoppers and caterpillars, at least, do not seem able to overcome the effects of a second injection.

SUMMARY.

1. Entomological text-books emphasize the importance of phagocytosis in ridding the insect body of foreign matter, but in reality insect blood cells are visibly rather passive.

2. Grasshopper and caterpillar blood cells do not seem to phagocytise bacteria in an amæboid fashion.

3. When bacteria are found within the blood cells, they may have gained entrance through their own aggression or physical factors may have been involved.

4. The blood of normal insects, however, is somewhat antagonistic towards bacteria.

5. This antagonism acts extracellularly.

6. Actively immunized grasshopper blood shows a high degree of antagonism towards the bacteria used in producing this immunity.

7. An agglutinin was found in immune grasshopper blood.

8. Some quantitative data on the bacteriacidal action of immune grasshopper blood were obtained.

LIPEURUS DOVEI *NOM. NOV.*

E. A. McGREGOR.
Bureau of Entomology, U. S. Department of Agriculture.

It was recently brought to my attention by Dr. A. Hassall through Dr. L. O. Howard that in naming *Lipeurus lineatus*[1] I have used a preoccupied name.[2] Therefore, as a substitute for *L. lineatus* I propose, as above recorded, the name *L. dovei*, in honor of Mr. W. E. Dove of the Bureau of Entomology who has been instrumental in collecting several new and interesting species of Mallophaga.

[1] PSYCHE, Vol. 24, No. 4, p. 114, 1917.
[2] Zeitsch. f. Ges. Naturw., Vol. 28, p. 384, 1866.

THE GENITALIA AND TERMINAL ABDOMINAL STRUCTURES OF MALE NEUROPTERA AND MECOPTERA WITH NOTES ON THE PSOCIDAE, DIPTERA AND TRICHOPTERA.[1]

By G. C. Crampton, Ph.D.

Since the Neuroptera form one of the most important groups for a phylogenetic study of the higher insects, the discussion of the condition met with in them, and in the closely allied Mecoptera, is here offered as the basis of a later, more detailed consideration of the genitalia of the Trichoptera, Diptera, and other higher forms which can be more profitably taken up in separate articles, and are therefore only briefly referred to in the present paper. The homologies here proposed are based upon a more extensive consideration of the genitalia of the males of the lower insects, published in the June, 1918 issue of the Bulletin of the Brooklyn Entomological Society, and forms one of the series of phylogenetic studies there listed.

Many of the accompanying rough sketches were made from material kindly loaned by Mr. Nathan Banks, to whom I am likewise indebted for identifications of specimens, and for the loan of valuable literature dealing with the subject. Dr. R. J. Tillyard has also furnished me with a number of intensely interesting Neuroptera for study, in addition to much valuable literature on Australian Neuroptera and Mecoptera. Since I have been largely dependent upon the generosity of others for material in carrying on the present investigation, I would make use of this opportunity of acknowledging my deep obligation and expressing my very sincere gratitude to Mr. Banks and Dr. Tillyard for their ready and generous response to a request for aid in furnishing material and literature for such a study.

It is indeed surprising that so little has been published concerning the homologies of the genitalia of male Neuroptera and Mecoptera, which are of the utmost importance for the correct interpretation of the parts in the higher forms. Since those who have referred to the genitalia of the groups in question have, for the

[1] Contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass.

most part, contented themselves with merely describing the parts, without comparing them with other insects, the homologies here proposed must be regarded as purely provisional, until more intermediate stages can be obtained in order to determine what paths of development have been followed in arriving at the different types of genitalia here represented, or until suitable material can be obtained for dissections which cannot be carried out with dried, borrowed material, or from single specimens, upon which I have been largely dependent! On this account, it is to be hoped that those who have specialized in these groups, and therefore have access to a wider range of forms and more favorable material, will carry out a more extensive study of the genitalia, in order to arrive at a definite conclusion concerning many of the points which a lack of suitable material has made it impossible to determine.

It is quite generally conceded that the Sialid group should be rated among the most primitive representatives of the order Neuroptera.[1] I have therefore selected *Corydalis*, *Chauliodes* and *Neuronia* (which are the most instructive representatives of the group, available to me) as the basis for a comparison with the higher forms here discussed. In these insects (Figs. 4, 10, and 15), the digestive canal opens through an anal tubercle called the *tuberculum*, *anoppilla*, or *proctiger* "ap." The two plates labeled "pa," one on either side of the tubercle "ap," were called *paraprocts* in a previous discussion of the parts in Neuroptera (Crampton, 1918), although I am not positive that they are the exact homologues of the paraprocts, or parapodial plates, of the Orthoptera and lower insects. In *Corydalis* (Fig. 15), the plate "pa" bears a pair of appendages "g," usually referred to as the *superior* and *inferior appendages of the gonopods*. For the sake of brevity they may be termed the *surgonopod* and *subgonopod*. The upper appendage, or surgonopod (Fig. 15) is the larger of the two, and appears to be the one to persist, when one of the two appendages is lost (as in Fig. 10, etc.).

Klapalek, 1903 (Bull. Int. Acad. Sci. Bohème), thinks that the gonopods of adult Trichoptera, etc. correspond to the "*Nachschiebern*" (anal prolegs?) of the larva. The gonopods of Neu-

[1] A study of the thoracic sclerites (which offer the most important characters for determining the relationships of insects) would indicate that the Neuroptera form a homogeneous group, which should not be further divided into "orders."

roptera, Mecoptera, etc., are usually homologized with the so-called "gonopods" of the Ephemerida (Fig. 6, "s"), but, as was pointed out in a previous paper (Crampton, 1918), the structures labeled "s" in Fig. 6 of the Ephemerid, are in reality *styli* which are segmented (*arthrostyles*) in some forms, and are composed of a single segment in others. The segmented styli (arthrostyles) labeled "s" in Fig. 6 of the Ephemerid are borne on the plate "hy" situated *below* the male genitalia, and therefore cannot be homologous with the gonopods "g" of Figs. 10, 15, etc., which are situated *above* the male genitalia, and are not borne on the plate "hy," so that I have retained the term "gonopods" for the structures labeled "g," in Figs. 10, 15, etc., and have applied the designation "arthrostyles" to the segmented styli of the Ephemerida.

The so-called "*mammilliform processes of the penis*," labeled "pu" in Fig. 15, and described by Van der Weehle (Megaloptera, Coll. Baron de Selys Longchamps) in *Corydalis*, etc.; may possibly be homologous with the structure called the titillator by Brunner von Wattenwyl, 1876, in the Orthoptera, since the structures in question are situated above the opening of the ejaculatory ducts in *Corydalis*, etc. (as is the case in the Orthoptera). The structures labeled "pu" in Figs. 4, 10, etc., on the other hand, are possibly homologous with the so-called penis hooks, or "*penunci*" of lower forms. For the sake of convenience, however, all the structures labeled "pu" are here referred to as "penis hooks," regardless of their position with reference to the opening of the ejaculatory ducts.

Ventral to the penis hooks "pu" of *Chauliodes* (Fig. 10) is a cylindrical column-like structure "co" called the *columna* in a previous discussion of the parts in Neuroptera (Crampton, 1918). Below this is the so-called *genital valve* "hy," which is homologous with the *hypandrium* or *subgenital plate* of the lower insects. In the lower forms, the plate "hy" of the males frequently bears a pair of styli; but I have been unable to find these in any of the Neuroptera or Mecoptera thus far examined. The lobe-like structure situated above the plate "hy" and labeled "sl" in Fig. 15, may possibly be homologous with the so-called *sublobi* of lower insects (Crampton, 1918).

In the Psocid shown in Fig. 17, there is a *supraanal plate* or *epiproct* "sa" situated above the anal opening, on either side of which is a *parapodial plate* or *paraproct* "pa." I would interpret

the callosity labeled "c" in Fig. 17, as the remains of the cercus (which appears to be lost, or vestigial in most Neuroptera), and the spine-like process "g" as the homologue of the gonopod "g" of *Chauliodes* (Fig. 10), although I am not sure that these interpretations are correct, until other material has been examined to determine these points. The Psocidæ seem to be as closely related to the Neuroptera as any of the lower insects, and may be regarded as annectent between the Neuroptera and the Embiid Plecopteron group, from which have also branched off the Isoptera to which the Psocids are likewise closely related.

It is impossible to draw any definite conclusions concerning the relationships of the different Neuropteroid insects from a study of the genitalia alone; but the following points of similarity of structure in the different groups may be noted. In the Sialid group (Figs. 2, 4, 10, and 15), the hypandrium, or subgenital valve "hy" is comparatively small, and the gonopods "g" with the paraprocts "pa" are usually represented, although they are not always well developed. The anal tubercle or proctiger "ap" is present in most of this group, while the supraanal plate is usually wanting.

Ithone (Fig. 14) is considered as one of the most primitive representatives of the Neuroptera-Planipennia, and presents certain features suggestive of the condition found in the Sialid group. In the dried specimen of *Ithone* here figured (Fig. 14) there appeared to be a somewhat shriveled anal tubercle or proctiger "ap." The structures labeled "g" in Fig. 14, are not very like the gonopods "g" of the Sialid group (Figs. 10 and 15); but resemble somewhat more closely the structures labeled "g" in the Myrmeleonidæ (Fig. 7) which have been provisionally homologized with the gonopods. The penis hooks "pu" of *Ithone* (Fig. 14) are quite unlike those of the other forms here shown, and are covered by an arched roof-like structure. The hypandrium or subgenital plate "hy" is well developed in *Ithone*, unlike the condition occurring in the Sialid group.

Polystoechotes (Fig. 8), which is one of the Planipennia, has no well developed hypandrium "hy," and a structure labeled "co" in Fig. 8, may possibly represent the columna "co" of the Sialid group (Fig. 10). If this is correct, the terminalia, or terminal abdominal structures of some Planipennia are not unlike those of certain Sialids. In *Nemoptera* (Fig. 12), another of the group

Planipennia, the hypandrium "hy" is even larger than that of *Ithone* (Fig. 14, "hy"). In *Nemoptera* there is a large columna-like structure (Fig. 12, "co") which has been homologized with the columna "co" of *Chauliodes* (Fig. 10), and in addition, a small "epicolumna" labeled "p" has been developed. The columna "co" of Fig. 12 bears two lobes at its apex, suggesting a bipartite origin for this structure, and it is possible that it may represent the united penis hooks "pu" (Figs. 4, and 10) rather than the columna "co" of Fig. 10. I have provisionally homologized the lateral plates "pa" of Fig. 12, with the paraprocts "pa" of Figs. 17 and 15; but I am not certain that this is the correct interpretation of these structures. The structures labeled "g" in Fig. 12 may not be the true gonopods, but have been provisionally homologized with them.

Nymphes (Fig. 3) is regarded as one of the least modified forms related to the Myrmeleonidæ; but it has been very difficult to interpret the parts aright in this insect, and I am by no means certain that the conclusions here reached are the correct ones. The hypandrium "hy" is well developed in *Nymphes* (Fig. 3), and the structures apparently homologous with the penis hooks, labeled "pu" in Fig. 3, are very large and bear several "prongs." The structure designated "sa" in the figure probably represents the supraanal plate (epiproct), although it may possibly be homologous with the anal tubercle instead. I have provisionally homologized the lobes "cl?" of Fig. 3 with the copulatory lobes "cl" of the Mecopteron shown in Fig. 18; but there is a possibility that they should be homologized with the plates "pa" of Fig. 17 instead. The parts of *Nymphes* (Fig. 3) are disappointingly unlike those of the Ascalaphidæ (Fig. 1) and Myrmeleonidæ (Fig. 7), although the Ascalaphidæ are very similar to the Myrmeleonidæ in having a dorsal plate "sa" (Figs. 1 and 7), which has been interpreted as the suranal plate or epiproct, and two elongate lateral processes "g" provisionally homologized with the gonopods.

Mantispa (Fig. 5) resembles *Nemoptera* (Fig. 12) in having a well developed hypoproct "hy," within which is a slender structure labeled "co" (Fig. 5), which may possibly be homologous with the structure interpreted as the columna "co" in Fig. 12. The two plates "pa" of Mantispa (Fig. 5) are possibly homologous with the plates labeled "pa" in Fig. 12 of *Nemoptera*.

Raphidia (Fig. 16) does not seem to be very like any of the other Neuroptera here figured so far as its terminal structures are concerned. It has an arched dorsal plate "sa" which may represent the supraanal plate, or epiproct, beneath which are two processes "g," provisionally homologized with the gonopods "g" of Fig. 10, etc. The two penis hooks "pu" of *Raphidia* (Fig. 16) are apparently homologous with the structures labeled "pu" in Fig. 5 of *Mantispa*, and the median hook "mu" of Fig. 16, is possibly homologous with the median hook "mu" of Fig. 5, although I am somewhat at a loss to account for the homologies of the structure "mu" of Figs. 5 and 16, in other forms.

The Coniopterygidæ (Fig. 11) are too small and highly specialized for one to be able to make very much out of a study of their parts. The hypandrium "hy," of Fig. 11, is comparatively well developed, and the structures labeled "pu" appear to represent the penis hooks "pu" of the other Neuroptera. The terminal structures of the Coniopterygidæ appear to resemble those of the Planipennia, as much as any other Neuroptera.

Turning next to the consideration of the genitalia and terminalia of the Mecoptera, we find two types represented, namely, those with forceps-like gonopods (*e. g.*, Figs. 24, 20, 23, 27, and 28) which are of extreme length in *Merope* (Fig. 24 "g"), and a second type represented by the *Bittacus*-group (Figs. 18 and 22) in which the gonopods are not developed in the form of forceps-like structures. In Vol. 27, page 298 of the *Entomological News* for July, 1916, I suggested that the *Merope* type of Mecoptera represented a suborder called the "Promecoptera," in which the wings present a very primitive venation, the head is not greatly elongated, etc. *Merope*, however, is quite closely allied to the other members of the *Panorpa*-group, and should be included in it, so that there are but two principal groups of living Mecoptera (the *Bittacus*-type and the *Panorpa*-type) and these two might be considered as representing two suborders of the Mecoptera, although they are more probably of merely superfamily rank. Tillyard, 1917 (Proc. Linn. Soc. N. S. Wales, 42, p. 188), applies the term Protomecoptera to a new order of fossil insects which in certain respects resemble the ancestors of living Mecoptera.

Although I feel certain that such forms exist, I have been unable to find any Neuroptera in which the gonopods are in the form of

jointed forceps-like structures as in the *Panorpa*-group (Figs. 24, 23, etc.), and since the *Bittacus*-group seems to be as primitive as any, so far as the terminal structures and genitalia are concerned, I have used them as the basis for a comparison with the other Mecoptera and the Neuroptera. *Bittacus* (Figs. 18 and 22) seems to resemble *Nymphes* (Fig. 3) as much as any Neuroptera, in respect to its terminal structures; and the median terminal appendage "sa" of Figs. 18 and 22, which is either homologous with the supraanal plate (epiproct) or with the anal tubercle (proctiger), is apparently the homologue of the median terminal structure labeled "sa" in Fig. 3 of *Nymphes*. The copulatory claspers "cl" of Bittacus (Figs. 18 and 22) are possibly represented by the lobes labeled "cl?" in Fig. 3 of *Nymphes*, and are analogous to, if not actually homologous with, the copulatory claspers, "cl," of the Phasmid shown in Fig. 9, and doubtless had a similar origin. The claspers "cl" are very large in *Bittacus strigosus* (Fig. 18); but are much smaller in *Bittacus pilicornis* (Fig. 22). Correlated with the greater development of the claspers "cl" of *Bittacus strigosus* (Fig. 18), there is a greater development of the appendages labeled "c" (which are provisionally homologized with the cerci) than in *Bittacus pilicornis* (Fig. 22), although in the latter insect, the median appendage "sa" is proportionately somewhat larger than that of B. *strigosus* (Fig. 18). In both insects shown in Figs. 18 and 22, there occurs a pair of closely approximated hooks labeled "pu," provisionally homologized with the penis hooks. Between them there projects a spiral thread or spirofilum "sf," wound like a watch spring. It is possible that this spiral thread represents the columna "co" of Fig. 10. At the base of the hooks "pu" (Figs. 18 and 22) is a pair of appendages labeled "g?" which may represent the gonopods of the other Mecoptera, although I would not insist upon this interpretation. Miyake, 1913, on the other hand, regards the hooks "pu" (Figs. 18 and 22) as parts of the "pedes genitales."

In comparing the *Panorpa*-group with the *Bittacus*-type, one of the most noticeable features is the lack of development of the claspers "cl" in the former group. On the other hand, the gonopods "g" are greatly developed in the *Panorpa*-group (Figs. 24 20, 23, and 27). I am not sure that the distal segment of the gonopod "g" of Fig. 23 is homologous with the appendage labeled

"g?" in Fig. 18, since it may correspond to the structure labeled "pu," instead; but I have provisionally adopted the interpretation indicated by the labeling. In most of the *Panorpa*-group there are one or two pairs of dorsal valves (dorsovalvæ), "dv" of Figs. 21, 23, 24, etc., and a pair of ventral valvæ (ventrovalvæ), "vv" of Figs. 23, 26, etc., and it is possible that certain of these valvæ may represent the penis hooks of Neuroptera, etc.

The anal tubercle "ap" of Fig. 21, bears at its base a pair of appendages "c" whose location suggests that they are homologous with the so-called cerci "c" at the base of the median terminal structure "sa" of Figs. 18 and 22. On this account, I would consider the structure "ap" of Fig. 21 as homologous with the structure "sa?" of Figs. 18 and 22, although I am not certain whether the structure labeled "sa?" in Figs. 18 and 22 is the epiproct "sa," or the proctiger "ap," of other insects. Tillyard describes a pair of segmented cerci in *Nannochorista* (Fig. 28, "c"), which appear to be homologous with the structures labeled "c" in Figs. 21, 23, etc., and on this account I have interpreted the latter structures as the cerci. I am not certain of the correctness of my interpretation of the structures labeled "c," as the cerci, and the structures labeled "dv," as the dorsal valvæ, in Fig. 24 of *Meropc;* but have provisionally adopted this method of homologizing them. The projecting ventral process "co" of Fig. 26, may be homologous with the columna, and if the latter is represented by the coiled filament "sf" of Figs. 18 and 22, the structure labeled "co" in Fig. 26 is doubtless to be homologized with the coiled filament "sf" also.

The phallus "pe" is large and prominent in *Borcus* (Fig. 20), and the hypandrium "hy" is well developed in this insect. In *Panorpodes* (Fig. 27) the structure which is here interpreted as the hypandrium "hy" shows a marked tendency to become long drawn out and furcate, although the cleft at its apex is not very deep. In the Panorpid shown in Fig. 26, however, the hypandrium "hy" is deeply cleft, and the two arms of the fork are comparatively long and narrow. The character of the hypandrium fork, the valvæ, etc., should be as valuable features for the purpose of classification as any structures, and it is surprising that they are not more employed in taxonomic keys.

The gonopods "g" of the Mecoptera here figured are composed of two segments. The basal one "pa?" of Fig. 23 may possibly

correspond to the paraprocts "pa" of the Neuroptera (Fig. 15, "pa"), although the elongate basal segment "g" of the gonopod of the very primitive Mecopteron *Merope* (Fig. 24) is nothing like the paraprocts in character, and this casts some doubt upon the supposition that the basal segment of the gonopods of the Mecoptera in general corresponds to the paraproct.

As was mentioned above, it is very strange that no Neuroptera have been described in which the gonopods are of the type represented in *Merope* (Fig. 24, "g") which is a very primitive Mecopteron in many respects, since the tendency toward the development of forceps-like gonopods occurs in many Mecoptera, Diptera, Trichoptera and other forms descended from Neuropteron-like forebears. The gonopods "g" of such Mecoptera as *Merope* (Fig. 24) are apparently the prototypes of those found in certain Diptera such as the Chironomid *Clunio* (Fig. 25, "g"). The occurrence of this type of gonopod in the Diptera lends further weight to the view that the Mecoptera are very like the ancestors of the Diptera.

Some Trichoptera have well developed gonopods, such as those of *Philopotamus* (Fig. 30, "g"), as might be expected from other evidence that the Trichoptera are rather closely related to the gonopod-bearing Mecoptera, both groups having apparently descended from Neuropteroid ancestors. The structures labeled "cl" occurring on either side of the supraanal plate "sa" of *Philopotamus* (Figs. 30 and 13) resemble cerci in some respects; but have been provisionally homologized with the clasper lobes "cl" of other forms. Klapalek, 1903, refers to similar appendages in the Trichoptera as the "appendices præanales."

As far as the relationships of the orders here discussed are concerned, I would maintain that the Neuroptera, Mecoptera, Diptera, Trichoptera and Lepidoptera constitute a superorder, the *Panneuroptera*, certain of whose members exhibit a tendency toward the formation of hairs or scales on the wings (*e. g.*, certain Myrmeleonids, a few Panorpids, the Psychodid Diptera, etc., in addition to many Trichoptera, and most Lepidoptera), and in most of which the meso-thoracic coxæ, at least, are divided into a veracoxa and merocoxa (see Crampton and Hasey, 1915, "The Basal Segments of the Leg in Insects;" Zoöl. Jahrb., Abt. Anat., 39, p. 1–), the mesothoracic and meta-thoracic coxæ are usually

approximated, there is usually a sternal fulcrum of the coxa (Crampton and Hasey, l. c.), and other characters showing that they have much in common.

I would group the Psocidæ, Thysanoptera, Mallophaga, Anoplura (Pediculidæ), Hemiptera and Homoptera in another superorder, the *Panhomoptera*, but by so doing, I would not minimize the close relationship of the Psocids to the Neuroptera, and the close approach of the Hemipteroid lines of development to those of the Mecoptera and Diptera. The Hymenoptera are closely allied to both the Psocidæ and the Neuroptera, and I have been unable as yet to determine in which of the two superorders they should be placed.

In connection with the discussion of the interrelationships of the orders of insects, it may be of some interest to note that it would appear that in the interesting little Crustacean *Bathynella* we have a form very like the common ancestors of the Insecta and "Myriopoda" (*sensu lato*). *Bathynella* belongs to a very ancient group of Crustacea, and the number of segments composing its body, the character of its appendages (which are lacking on the last segments), etc., are all in accord with the view that it is very like the ancestors of the Proturan insects. *Bathynella* is also very like the probable ancestors of the Symphyla-Pauropoda, a group which has departed but little from the condition characteristic of the ancestors of the "Myropoda" as a whole.

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Abbreviations.

ap = Anal tubercle, anopappilla, or proctiger.
c = Cerci, or vestiges of cerci.
cl = Copulatory lobes, or copulobi.
co = Columna.
dv = Dorsal valvæ, or dorsovalvæ.
pa = Parapodial plates, or paraprocts.
pe = Phallus.
pr = Preepiproct.
pu = Penis hooks, or penunci.
s = Jointed styli, or arthrostyles.
ep = Epicolumna.
f = Pendent filaments.
g = Gonopods, or their homologues.
hy = Subgenital valve, or hypandrium.
mu = Median hook, or mediuncus.
sa = Supraanal plate, or epiproct.
sf = Spiral filament, or spirofilum.
sl = Sublaminæ.
t = Terminal filament, or telofilum.
vv = Ventral valvæ, or ventrovalvæ.

Explanation of Figures.

Unless otherwise stated, figures are of terminal structures and genitalia.

Plate II.

Fig. 1. Lateral view of an Ascalaphid (Neuroptera).

Fig. 2. Lateral view of *Sialis* (Neuroptera).

Fig. 3. Lateral view of *Nymphes myrmeleonides* (Neuroptera).

Fig. 4. *Nigronia serricornis*, Say (Neuroptera), lateral view.

Fig. 5. *Mantispa brunnea*, Say (Neuroptera), lateral view.

Fig. 6. *Ephemera varians?* (Ephemeridæ), lateral.

Fig. 7. *Brachynemurus longicaudus*, Br. (Neuroptera), lateral view.

Fig. 8. *Polystachotes punctatus* Say (Neuroptera), lateral view.

Fig. 9. *Clitumnus lævigatus*, Br. (Mantidæ), lateral.

Fig. 10. *Chauliodes pectinicornis*, L. (Neuroptera), lateral.

Fig. 11. A Coniopterygid (Neuropteron), lateral.

Fig. 12. *Nemoptera sinuata* (Neuroptera), lateral. Restored from crushed specimen.

Fig. 13. *Philopotamus* sp. n (?) (Trichopteron), dorsal view of lobes and suranal plate.

Fig. 14. *Ithone*, sp. (probably I. *fusca*), Neuropteron, lateral view.

Fig. 15. *Corydalis cornutus*, L. (Neuroptera), lateral.

Fig. 16. *Raphidia occulata*, Banks (Neuroptera) lateral.

Fig. 17. Lateral view of a Psocid, probably *Psocus venosus* Burm. It is a large winged form found in colonies on pines near Amherst, Mass.

Plate III.

Fig. 18. *Bittacus strigosus*, Hag. (Mecoptera), lateral.

Fig. 19. *Panorpodes* (Mecopteron) from N. Carolina, dorsal view of apex of genital segments.

Fig. 20. *Boreus brumalis*, Fitch (Mecoptera), lateral.

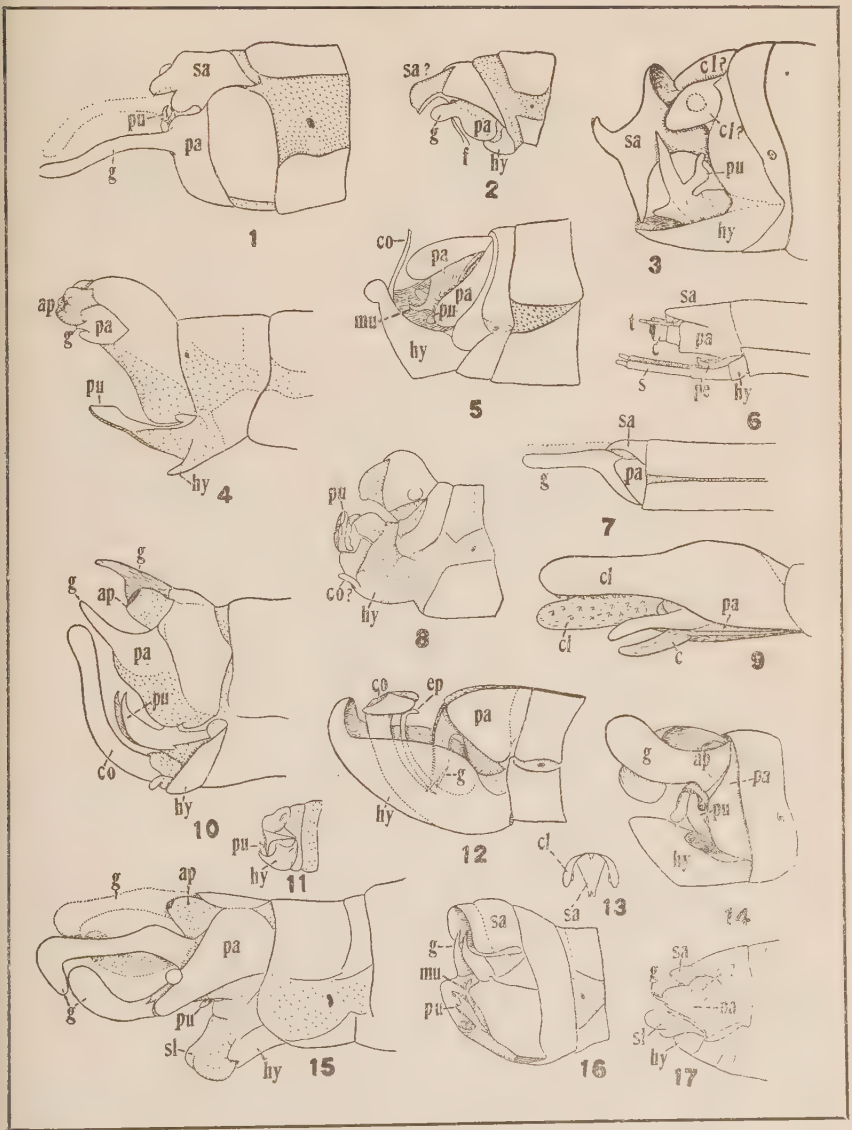
Fig. 21. *Panorpa lugubris*, Swed. (Mecoptera) dorsal view of genital segments, the upper plate "pr" of Fig. 23 removed, and anal tubercle bent back.

Fig. 22. *Bittacus pilicornis*, Westw. (Mecoptera), lateral.

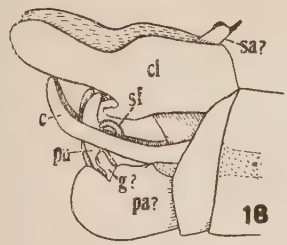
Fig. 23. *Panorpa lugubris*, Swed. (Mecoptera) lateral.

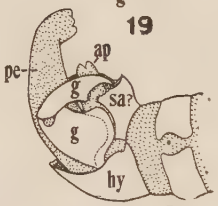
Fig. 24. *Merope tuber*, Newm. (Mecoptera) dorsal.

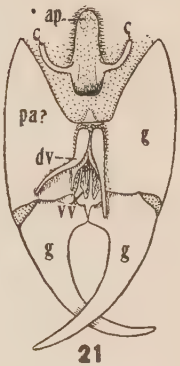
Fig. 25. *Chunio bicolor*, Kieffer (Diptera), based on Fig. 1, Plate 4, of fascicle 42 on Chironomid Diptera, by Kieffer, 1906 (Genera Insectorum).

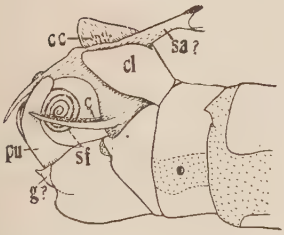


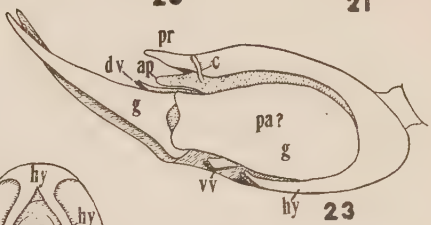
CRAMPTON—Genitalia and Terminal Abdominal Structures.

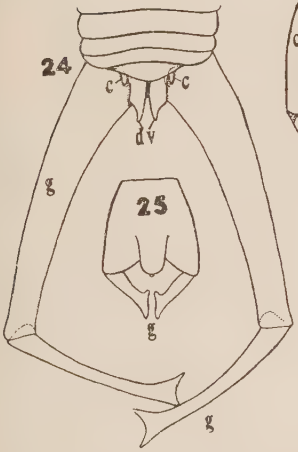


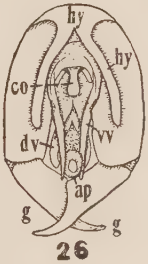


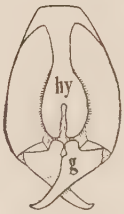


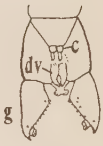


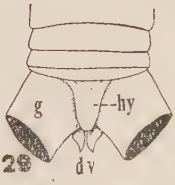


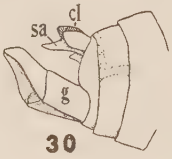












CRAMPTON—Genitalia and Terminal Abdominal Structures.

Fig. 26. *Panorpa nebulosa*, Westw. (Mecoptera), ventral.

Fig. 27. *Panorpodes* of Fig. 19, ventral.

Fig. 28. *Nannochorista dipteroides*, Tillyard (Mecoptera), dorsal view, based on Fig. 11 of Plate XVII, by Tillyard, 1917 (Proc. Linn. Soc. N. S. W.).

Fig. 29. *Merope tuber*, Newm. (Mecoptera), ventral. Gonopods cut off.

Fig. 30. *Philopotamus* Sp. n.? (Trichoptera), lateral.

NOTES ON *TRIOZA ALACRIS* FLOR IN NEW JERSEY.

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This Psyllid, which was introduced into New Jersey from Belgium and which is well known and destructive in Europe, has already been recorded as occuring in New Jersey (Weiss, Canadian Ent. Feb., 1917, pp. 73–75). D. L. Crawford in the Monthly Bulletin of the California State Commission of Horticulture Vol. I, No. 3, p. 86, gives an account of its presence in California together with suggestions for its control and also treats it in his Monograph of the Psyllidæ of the New World, Bull. 85, U. S. N. M.

It occurs in New Jersey on bay trees which are kept either under glass all the year or out of doors during the summer and under glass the remainder of the year. The following observations were made on trees kept outside during the summer months. Its presence on Bay (*Laurus nobilis*) can be readily detected by the curled, discolored, swollen, blistered leaves, usually at the tips of the branches, containing what appear to be whitish masses. Upon uncurling a leaf the nymphs are readily seen clothed in a white waxy secretion. In severe infestations the tree has a sickly and unwholesome appearance.

In New Jersey, the Psyllid overwinters as an adult on bay trees, which are kept in storage houses where the temperature is never allowed to go below 38 or 40 degrees F. About the middle or end of May according to the weather, the trees are moved outside and at is then when egg laying starts.

[1] The arrangement of the authors' names has no significance and indicates neither seniority nor precedence.

The minute, elliptical shaped eggs are laid on the under sides of young leaves near the margins, from 25 to 200 having been found in a single, elongated, irregular cluster. The leaves containing eggs were always found to be rolled in tightly and downwardly toward the midrib. The nymphs feed within the curled leaves and during the summer all stages of the insect can be found at the same time upon the same tree showing that egg deposition evidently extends over several weeks. The nymphs are covered over with white, waxy masses excreted from their bodies. Inside of a curled leaf can also be found globules of honey dew covered over with a waxy material and in many cases colonies of mealy bugs. The last stage nymphs move out of this sticky mess just before the adult is ready to emerge and rest on a drier and cleaner portion of the leaf just beyond the pseudo-gall.

About the middle of July adults of the first brood are appearing showing that about six weeks are required for a complete life cycle. About the first of September adults of a second brood can be found. These continue to appear for a month or so longer, even as late as November when the trees are in storage, provided the weather is not cold. The cool days during the fall undoubtedly prolong the numphal stages which are active only during warm weather and and this accounts for the delayed time over which the adults appear. These adults remain on the trees during the winter, many of them clustering around the pseudo-galls. On cold days they can be collected without difficulty on account of their dormant condition. On warm days during the winter the temperature of the storage house rises and at that time the adults are active when disturbed.

While contact insecticides are useful, it is impossible to reach the nymphs in the curled leaves which are protected still further by wax and honey dew. In New Jersey almost complete killing was secured in one case by fumigating with tobacco smoke as for aphids while the trees were in storage and heavenly infested by overwintering adults. Hydrocyanic acid gas has also been used with success (See Review of Applied Entomology, Series A, Vol. II, p. 482). It is the practice of some firms to have their men go over infested trees and pick off all curled infested leaves, but this is a slow process in a large establishment.

Egg: Length 0.2 mm., greatest width 0.1 mm. Outline oval with distal end acutely pointed, rounded at basal end. Acute

distal tip transparent, remainder opaque. Inserted in leaf tissue by means of a minute extension at basal end. One side rests close to leaf surface and becomes flattened. Other side is convex.

The following descriptions were made from alcoholic material.

First Stage Nymph: Length 0.21 mm., greatest width 0.1 mm. Color white; shape oval, broadly rounded at both ends, slightly sinuate at anterior margin; broadest across middle of thorax which gradually narrows at posterior extremity. Abdomen narrower than thorax. Body segmentation somewhat indistinct, that of abdomen indicated. Head, thorax and abdomen subequal in length. Body sparsely covered with minute hairs. Eyes indicated by red spots on lateral posterior margins of head. Antennæ length about one-third width of thorax, cone shaped, twice as long as width of base, tip slightly truncate; a minute spine arising from tip with a smaller one below. Legs, length, two-thirds the width of the thorax, gradually tapering toward tip; segmentation indistinct; apical end of leg bearing a sucker disc and a spine. Rostrum long, fine, hair-like; basal sheath extending to between bases of third pair of legs.

Second Stage Nymph: Length 0.3 mm., greatest width 0.15 mm. Color white; shape rectangular to broadly oval. Anterior end of body truncate, outer angles broadly rounded. Body gradually widening to posterior third of thorax, then gradually narrowing to posterior thoracic margin. Abdomen slightly narrower than thorax, posterior end rounded. Body sparsely hairy, segmentation indistinct. Antennæ cone shaped, length one-fifth width of thorax, outer extremity transversely ridged bearing two spines at tip. Legs similar to those of preceding stage except that they are proportionately larger and the sucker disc is missing. Tip of leg bears a pair of minute hooks. Eyes red. Basal sheath of rostrum extends to bases of second pair of legs.

Third Stage Nymph: Length 0.5 mm., greatest width 0.22 mm. Similar to second stage in shape and color except central dorsal portion of thorax and posterior margins of abdominal segments which are tinged with brown. Lateral margin of thorax bears a row of minute spines. A pair of these spines on lateral margin of each abdominal segment. Antennæ similar to those of preceding stage, length, one-sixth width of thorax. Eyes and legs similar to those of preceding stage. Basal sheath of rostrum extending to bases of second pair of legs.

Fourth Stage Nymph: Length 1 mm., greatest width 0.51 mm. Color similar to that of preceding stage. Shape oval; truncate and sinuate at middle of front; outer angles of head broadly rounded. Division between head and thorax indicated by slight indentation at lateral margin. Thorax gradually widening to posterior portion where it is broadly rounded. Dorsal surface of head and thorax covered with a shield like expansion. Wing-pads visible and extending to posterior margin of thoracic expansion. Abdomen narrow at anterior margin, broadening to anterior fourth; remaining portion broadly rounded so that abdomen is almost circular in outline. A fringe of minute spines on lateral margins of head and thorax. Several spines on lateral margin of each abdominal segment. Eyes dark brown. Antennæ broadest at base, gradually tapering to tip which is slightly truncate. Antennæ more or less transversely ridged. Apical segment is one and one-half times the length of the basal segment. Tip of apical segment bears two spines. Legs three jointed, somewhat curved. The two basal segments are subequal in width, surface of second segment slightly convex, third segment slightly convex and tapering to tip which bears a pair of minute hooks. Legs bear a few minute scattered hairs. Basal sheath of rostrum extending to bases of second pair of legs.

Fifth Stage Nymph: Length 1.7 mm., greatest width 1 mm. General shape oval. Dorsal shield like expansion of head and thorax more pronounced. Head truncate in front, slightly convex, lateral margins broadly rounded. Front and anterior dorsal portion of head bearing a number of minute spines resting on minute tuberculate bases. Lateral expanded margins of thorax abruptly rounded from sides of head. Sides of thorax moderately convex extending to posterior margin of second abdominal segment. Wing-pads extending to posterior margin of shield like expansion. Lateral margin of prothorax bears a row of minute spines each resting on a minute tuberculate base; a few scattered minute spines on dorsal surface near margin especially in the anterior region. Sides of abdomen are convex making it broadly oval in outline. Abdominal segments well defined, lateral margins of each bearing a number of minute spines resting on minute tuberculate bases. A number of very minute spines on dorsal surface near margins. Eyes prominent, lateral, covered by dorsal expansion of head.

Antennæ arising in front of eyes, apparently five jointed, length, four-fifths the width of the head; two basal segments covered by dorsal expansion of head. Antennæ transversely ridged; apical segment slightly club shaped, tapering to point and bearing two spines at tip and one on lateral margin. Legs three jointed; basal segment broadest, sides convex especially outer surface; second segment slightly longer than basal segment, sides parallel. Apical segment one-third length of second, slightly narrower; outer surface broadly rounded to inner forming tip terminated by a pair of hooks. Second and third segments bear a few scattered hairs. Basal sheath of rostrum extending to just beyond bases of first pair of legs.

Adult: Trioza alacris Flor, syn. *Trioza lauri* Targ. The following description is by Crawford (Bull. 85, U. S. N. M.). The original description by G. Flor appeared in "Zur Kenntniss der Rhynchoten Beschreibung neuer Arten der Familie Psyllodea Burm., Moskau, 1861." "Length of body 1.9 mm., length of forewing 3.2, width of head 0.71. General color greenish yellow to light brown; dorsum in darker individuals more or less striped and streaked with brown; abdomen often brown; antennæ black at tip.

"Head nearly as broad as thorax, not strongly deflexed; vertex more than half as long as broad, emarginate in front at median line, with a prominent sulcate impression on each side of median line and parallel to it; genal cones scarcely two-thirds as long as vertex, divergent, subacute, pubescent, not much depressed from plane of vertex. Antennæ about one and one-third times width of head, slender. Thorax not broad, well arched, punctate; pronotum moderately long, not strongly depressed; præscutum rather large. Legs slender; hind tibiæ with two black spines at apex on inside and one outside. Wings long, slender, transparent, fully three times as long as broad, subacute at apex; Rs short.

"Genitalia—male—Anal valve a little longer than forceps, hind margin arcuate, with long pubescence; forceps rather stout, sides almost parallel (from sides), terminating in a subacute, black point at apex.

"Female—Genital segment nearly as long as rest of abdomen, acute at apex, valves subsequal in length."

HEMIPTEROLOGICAL NOTES.

By H. M. Parshley.
Smith College, Northampton, Mass.

Anasa repetita Heidemann.

On September 19, 1917 at Northampton, Mass., I found this species in large numbers feeding on the Star-cucumber, *Sicyos angulatus* Linn. More than fifty examples, both adults and nymphs, were taken on two vines. The rarity of the species in collections is undoubtedly due to the fact that its food-plant has been unknown to collectors. I noted one example of *Anasa armigera* Say on the same plant and another in flight nearby.

Melanolestes picipes var. abdominalis Herrich-Schaeffer.

The forms of this Reduviid which exhibit more or less red on the abdomen are usually considered to constitute a distinct species, *M. abdominalis*, as originally described by Herrich-Schaeffer, although there seem to be no structural criteria to separate the two. Stal[1] treated *abdominalis* as a color variety (var. b) of *picipes*, but Uhler[2] felt that the evidence at his command did not warrant his merging them, since he never found the two forms united in copulation though both often occured under the same stone. I have in my collection examples showing all gradations from those having only the slightest tinge of red along the connexivum to those having the abdomen entirely red; I have also a pair taken in copulation (Framingham, Mass., C. A. Frost) in which the male is an entirely black long-winged *picipes* and the female a short-winged *abdominalis*, with red connexivum. It would seem therefore that the *abdominalis* form should be ranked as a mere color variety and not as a species distinct from *picipes*, as I have done in my New England list.

The consideration of this case brings up the matter of color varieties and subspecific forms in general. In the study of some groups of insects, notably ants, the subdivisions of species are treated according to a definite system based on a relatively com-

[1] Enum. Hem. 2, 1872, p. 107.
[2] Hem. west of Mississippi River, Bull. U. S. Geol. & Geog. Surv. Terr., II., No. 5, 1876, p. 330.

plete knowledge of the forms, the concepts *subspecies* and *variety*, for instance, being distinct and clearly formulated. The study of the Hemiptera is less advanced, and there is usually insufficient ground for deciding whether a certain form of a species is to be considered subspecific (racial) or varietal in this strict sense. This being the case I have thus far denominated as varieties all forms of less than specific value, and have used trinomials in their designation, leaving it to be inferred that all such varieties pertain, perhaps, to the typical subspecies, as their frequently coincident ranges would seem to indicate.

Recently a tendency has become very evident to give definite varietal names not only to forms characterized by slight structural peculiarities but also to those differing only in color. Examples of the latter are to be found in the Mirid genera *Horcias*[1] and *Paracalocoris*.[2] Specimens of *Horcias dislocatus*, for instance, may be almost entirely black, almost entirely red, or conspicuously striped with red, black, and yellow. But a varied and more or less intergrading collection of these different forms may sometimes be taken from a single branch, and may very possibly have issued from the same batch of eggs. Thus such "varieties" represent a very different conception from the varieties of the myrmecologist, corresponding in some cases, no doubt, to his unnamed "nest-varieties," and this must be borne in mind in considering the trinomial names of Hemiptera.

As remarked by McAtee, it seems unscientific to make no attempt in collections and taxonomic treatments to separate these often totally distinct appearing forms, and if they are to be separated they should be given names for several good reasons. I have recently received communications on the subject which lead me to suggest that this matter calls for discussion with a view to bringing hemipterological concepts and nomenclature into harmony with the ideas established in the study of groups which are better understood. At present I, for one, use the term *variety* noncommittally to designate subdivisions of the species (*not* aberrations) which I think should be named, but without any structural, geographic, or genetic connotation.

[1] Van Duzee, E. P. Hemipterological Gleanings, Bull. Buffalo Soc. Nat. Sci., Vol. 10, 1912, pp. 477–512.

[2] McAtee, W. L. Key to the Nearctic species of Paracalocoris, Ann. Ent. Soc. America, Vol. 9, 1916, pp. 366–390.

TRICHOPROSOPON THEOBALD (DIPTERA; CULICIDÆ).

C. S. Ludlow.
Army Medical Museum, Washington, D. C.

Some specimens of this interesting genus from the Canal Zone bring up again the question of synonymy.

The species under consideration is quite possibly new, and as such is described below, but there is a certain amount of uncertainty on the subject arising from the following conditions. The specimens were compared with all the available descriptions and coincided with none, then they were taken to the National Museum where, what I believe to be identical specimens were found, but which H. D. & K. had referred to and described as *Culex digitatus* (*Joblotia digitatus*) Rondani, and Theobald's *Trichoprosopon nivipes* was reduced to a synonym under this species. Of course the original description by Rondani is, as are all short descriptions, too indefinite to be of much value, and Theobald's description of *nivipes* does not cover these specimens unless the note under "Observations" at the end of his description modifies it sufficiently to do so. At all events, my specimens have, in eight males, always the distal tarsal joint of the mid-legs and the apex of the fourth point, brown, as will be seen below. The specimens in the National Museum show the same condition, and the very tip if the distal joint in the female is also brown. It may be, of course, a local variation, as Theobald's specimens came from Trinidad, and mine from the Canal Zone, but Theobald speaks of his species having "pure white" joints, and it seems quite unlikely that he could have included *purely brown* under that wording. Whether the species be *digitatus* is, of course, open to question, but it seems possible that there may be some closely allied species. At all events I do not think these specimens from the Canal Zone are *nivipes*, and at the risk of adding to the synonymy I am describing these as:

Trichoprosopon Wilsoni sp. nov.

Head dark, covered with flat dark scales having deep (cobalt) blue to white iridescence, and a line of dark forked-scales at the nape, two heavy chaetæ projecting forward between the eyes and some shorter ones behind the eyes; proboscis dark, long, of uniform

width, dark highly iridescent (blue-greens to copper colored) scales, the apex at times almost white, labellæ dark; palpi dark, very slender, as long or slightly longer than the proboscis, unplumed, apical joint acuminate; antennæ light stemmed, with narrow dark bands, and heavily dark verticelled, two rows in each whorl, the slender apical joints at times appearing white; the first joint testaceous and rather heavily scaled on the median aspect; clypeus dark, heavily clothed with, and having a heavy fringe of dark hairs; eyes dark turning to copper color.

Thorax pro-thoracic lobes sub-lateral, with flat scales, probably brown, but with brilliant blue to white iridescence, and a few short dark bristles; mesonotum dark with flat closely appressed golden to bronze scales on the cephalo-laterad portion, a few dark bristles on the median line at the nape, and the rest of the mesonotum covered with dark brown spindle-shaped or broadly curved scales, and short brown bristles on the lateral margins and at the wing joints; the scutellum is light testaceous, clothed with dark flat scales having blue (cobalt) to white iridescence, six bristles on the mid-lobe and two to four (apparently variable) bristles on the lateral lobes; metanotum dark brown with a small bunch, probably about ten short, dark bristles at the median apical point and about four rows of flat scales with blue to white iridescence extending from these bristles to the base of the metanotum on the median line; pleura light, well clothed with brilliant white (silvery) small flat scales.

Abdomen covered with dark brown scales having brilliant (cobalt) blue iridescence that in some lights runs toward mauve, but seems not to lose the blue entirely at any time. There are large light golden lateral spots, rather heavier at the apex of the segments, and the same color extends on the venter which is markedly banded with dark scales on the apex of most of the segments. The apical joints are definitely bristly, and the bases of the claspers rather heavily scaled.

Legs, coxæ and trochanters light scaled, but with a narrow blue band; femora are as a whole dark dorsally, the scales having a brilliant blue to purplish iridescence, and the ventral aspect has light yellow to copper colored (or bronze) scales sometimes extending well toward the knee joint, all are heavily scaled at the apex forming a bunched effect. The remainder of the fore legs is

all dark with the brilliant iridescence found on the femur. On the mid-legs the tibiæ have the same dark iridescent scales except at the base where there is a small white spot, more easily seen on the ventral aspect; the first tarsal is dark, the second is mostly white but has a few dark scales, or they show dark reflections on the dorsal aspect, the third is also mostly white except the tip which is dark and on the dorsal side there may be a few scattered dark scales, the fourth joint is practically dark on the dorsal aspect and either whitish or ringed black and white on the ventral side, depending on the position of the light, while the fifth joint is usually wholly dark, but may show light reflections on a few scales, on some specimens, depending on the angle of the light. The ungues on the fore- and mid-legs are large, unequal and simple. On the hind legs the tibiæ are dark save for a brilliant white spot at the base, and so are the first tarsals but the white spot is much smaller, the second and third joints are dark, and the fourth and fifth are pure white (in some specimens a dirty white) with occasionally a tiny dark spot at the extreme tip. There is a line of porrect scales on the distal half of the tibia, extending on the first tarsal (H. D. & K.'s "scraper"?).

Wings are long and slender (285–50), the membrane clear and the veins clothed with "Tæniorhynchus" like scales, those on the costa, subcosta, and the fork of the second long vein almost obvate, and having a brilliant blue iridescence; the cells are very long and slender (80–5). First submarginal nearly one-third the length of the wing. The stems are proportionally short, not over one-fifth the length of the first submarginal and that of the second posterior slightly longer; the cross veins are nearly in a line, the mid and posterior about equal in length. The halteres have the base very light, but most of the stem and the knob are dark.

Length: 6–6 mm.

Taken: December 1, Larvæ found in a coconut shell.

Habitat: Chagras Camp, Las Cascades, Canal Zone.

The species lies near *nivipes* and of course may be *digitatus* but is believed to be new, in spite of the fact that what seems to be the same female is described by H. D. & K. as *digitatus* and the peculiarities of the male mid-legs are not referred to.

Colonel W. H. Wilson, M. C., who sent me the specimens says they are markedly canabalistic, the larvæ eating not only the young of other species, but even the smaller members of their own species.

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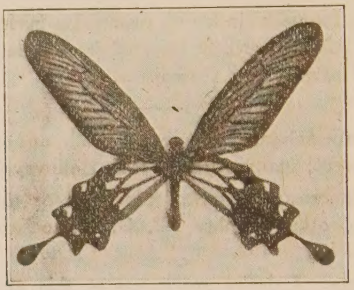

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